URBAN AND REGIONAL DEVELOPMENT

Towards the Healthy City: modeling UHI mitigation

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Context of the research activity	Urban Heat Island (UHI) due to global warming affects people’s health and quality of life. Technologies for high space-time UHI modeling, simulation and analysis, is central towards performance-based transformation scenario assessment. The research goal is to improve knowledge on such phenomena, causalities and effects from the neighborhood to the urban scale integrating data coming from several domains, socio-economic and epidemiologic, to support climate-proof adaptation design strategies.

	Target 11.b combines short-term local strategies for the built environment adaptation and long-term mitigation policies to finally cope with global climate crisis. Moreover, seeking to transform cities and human settlements into inclusive, safe, resilient and sustainable ones, SDG 11 manifests many positive interlinkages with all other Goals of the Agenda 2030. Besides, measuring by modeling techniques, time series and distributed sensors is now enabled by the pervasiveness of the technologies, widely recognized for SDG achievement. UHI mitigation underpin many positive interlinkages with several Goals (3, 7, 12, 13 and 15 among the others), but its assessment is barely performed by taking into consideration the interactions among built environment, natural elements and people habits. Satellite imagery has greatly contributed to the knowledge on Surface Heat Island, but Remote Sensing (RS) techniques imply certain limitations. As an example, they provide frames on certain instants under specific meteorological conditions at

Objectives	urban or regional scale, mainly depending on physical attributes of surfaces. On the contrary, high-resolution UHI modeling takes into account the interactions among boundary conditions and site-specific features, but it still requires a high domain specialization and produce not georeferenced data, which are hardly accessible by stakeholders. Given the complexity of the interactions among mentioned phenomena, integrating RS with modeling (specifically, numerical models and Computational Fluid Dynamics), field measurement by pervasive sensor networks for monitoring environmental variables and GIS software may constitute a turning point into UHI assessment for designing transformations scenarios able to cope with both climate adaptation and mitigation. Thus, the goal of the research is to elaborate methodologies and strategies for integrating data coming from RS, models, and field measurement to finally produce an urban-scale open climate geodatabase, to be integrated into future urban Digital Twins as a fundamental “knowledge layer” informing present and future assessment, policies, and design. Specifically, high-resolution modeling and field measurement by low-cost Internet-of-Things (IoT) devices will unveil district-scale dynamics resulting in thermal stress exposure and health hazards from pollution, while scaling up simulations to the city level will provide a full overview on phenomena that affect UHI. To this, the city surface will need to be discretized in plots, overcoming the scale limitations of CFD in performing simulations at urban level. Then a proper methodology has to be designed for turning data into georeferenced information, not really already present in the sector studies and research. Meteorological boundary conditions have to be set according to time series analysis and climate future projections based on IPCC scenarios, seeking to produce present and future “labeled” environmental conditions informing climate simulations. Finally, the knowledge produced will be integrated with satellite imagery into GIS environments and information coming from other domains (e.g., population density, epidemiological data, accessibility to green spaces, healthcare facilities…), demanding high multidisciplinary expertise. As for the research program, during the first year the scientific background in the field of adaptation and mitigation strategies, policies and technologies at urban and district level will be carried out focusing on the role of simulation and measurements tools at urban and district level. Moreover a framework will be outlined aimed to define scenarios and objectives of the research (i.e. climatic trends, adaptation techniques, policies, NBS etc.) The second research year will be devoted to design a methodology for the analysis of the urban fabric matching the outcomes of the research in the urban form and morphology studies with the tools available for the description and visualization of phenomena at different levels (climatic, environmental, social etc.) as GIS. In this stage, the contribution of the SDG11 Lab will be central for elaborating a robust and innovative methodology and achieving the results. Specifically, the candidate will carry out the integration of results from simulation tools as well as from networks of sensors investigating the spatialization of data and information and its potential in urban analysis and design. Moreover, performing CFD simulations, highly computationally demanding, could be supported by the SDG11 laboratory. During the third year, the methodology designed will be implemented in one or more case studies, and will be discussed and assessed by an iterative validation with selected stakeholders thanks to collaborative design techniques. Transformation scenarios will be finally designed and assessed according to the goals of the research and evaluated in the context of the most advanced researches in the field.

Skills and competencies for the development of the activity	The skills required for the research are an attitude to interdisciplinary research in the field of adaptation and mitigation related to urban health. The interest in investigating the UHI phenomena and the NBS role in mitigation and adaptation will be appreciated.